



The Diabetic Foot Organization in the Republic of Serbia

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Abstract

Objectives: To evaluate the burden of diabetes-related peripheral arterial disease (PAD) and lower-extremity amputations (LEA) in Serbia using data from the Serbian Vascular Registry (SerbVasc) and to assess the impact of newly implemented digital and endovascular strategies on patient management. **Methods:** SerbVasc, a national registry, was established in 2019 and fully implemented in 2020, and includes data from 27 Serbian hospitals. Two published studies were analyzed: 702 patients undergoing LEA (2020-2022) and 1681 patients treated for PAD (2020-2023). Demographic characteristics, comorbidities, revascularization procedures, complications, and mortality were evaluated. Additionally, outcomes following implementation of an electronic consultation platform (eConsultations) for diabetic foot management were assessed. **Results:** Diabetes mellitus was present in 65% of LEA patients and 40.2% of PAD patients, while smoking prevalence exceeded 60% in both cohorts. Prior revascularization before amputation was infrequent, and nearly half of amputations were above the knee. Mortality after LEA approached 7%, particularly among older patients and those with cardiovascular comorbidities. In PAD patients, endovascular interventions increased significantly, especially among patients with diabetes. Following implementation of the eConsultations system, preliminary results from the University Clinical Centre of Serbia reported a 20% reduction in LEAs in 2025 and a more than twofold increase in below-the-knee endovascular procedures compared to 2024. **Discussion:** Delayed diagnosis, limited number of revascularization procedures, and high prevalence of modifiable risk factors contribute substantially to amputation burden in Serbia. **Conclusions:** National registries, multidisciplinary collaboration, digital communication platforms, and expanding endovascular expertise may significantly improve outcomes in diabetes-related vascular disease.

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Key words: diabetic foot, national registry, endovascular treatment, limb ischemia

Introduction

Diabetes mellitus (DM) presents a major global public health challenge, with prevalence increasing across most geographies, particularly in Europe. Serbia is among the countries most affected by this trend. According to 2021 data, the prevalence of DM in Serbia reached 12.2%, marking a substantial rise compared with the previous decade.¹ This growing prevalence has been accompanied by an increase in diabetes-related complications, most notably diabetic foot and lower-limb amputation.^{2,3} In response to this escalating burden, Serbia has been faced with a new and increasing problem that prompted medical health practitioners to develop new strategies that could enable better treatment and lower amputation risk in these patients. One such initiative is the Serbian Vascular Registry (SerbVasc), with the aim of establishing enhanced monitoring, treatment, and prevention of vascular complications in patients with diabetes.

Methods

The SerbVasc registry was developed in 2019 as a pilot project supported by the Republic of Serbia, with full implementation in everyday clinical practice beginning in 2020. As of today, the SerbVasc registry includes data from 27 hospitals across Serbia, including 4 University Clinical Centers and 1 Institute for Cardiovascular Diseases, which serve as leading institutions in the management of these patients.

Among the participating hospitals, 2 are classified as high-volume centers (with more than 88 endovascular procedures per year), 7 middle-volume centers (with 22-88 endovascular procedures per year), and 18 low-volume centers. Both high-volume centers are in Belgrade, and one of the goals of this program is to support the decentralization of patient care as much as reasonably possible, ensuring broader access to high-quality treatment throughout the country.

The SerbVasc registry collects comprehensive data on all vascular procedures, including interventions on the carotid arteries, thoracic and abdominal aortic pathology, vascular trauma, hemodialysis access, and graft infections. However, of particular relevance to diabetic foot management are detailed records of peripheral arterial disease (PAD) procedures and lower-limb amputations. All procedures documented in the registry are performed by vascular surgeons, interventional radiologists, or general surgeons.

Results

Within only 3 years of the registry's formation, 2 significant studies focusing on lower-extremity amputations (LEA) and PAD were successfully published. These publications provided clinicians in Serbia with a clearer understanding of the current burden of disease and complication rates, and they supported the development of improved treatment strategies for affected patients.

In the first paper, information about 702 patients who underwent LEA from January 2020 to December 2022 were analyzed. The mean age of the patients was 69.06 ± 10.63 years, with male patient predominance (almost 70%). DM was recorded in 65% of patients, and 44% of those patients were receiving insulin therapy. However, one of the most common modifiable risks—smoking—was noted in almost 62% of the patients, predominantly among men. Smoking is a well-established risk factor for cardiovascular diseases, including PAD, and has a significant negative impact on both disease development and treatment outcomes.^{4,5} While smoking prevalence has been gradually declining in many developed countries mainly due to cost increases,⁶ Serbia remains among the countries with the highest per capita cigarette consumption in Europe.⁷ This observation prompted us to focus on a new study aimed at addressing smoking as a target for prevention, with an emphasis on both primary prevention strategies and reduction of cigarette use.

A particularly important finding was the low rate of prior revascularization: only 20.3% of patients had undergone a revascularization procedure at any time, only 5.1% of patients during the current hospitalization before undergoing amputation, and only 7.7% had been treated using an endovascular approach, with the femoral region being the most commonly treated (38.9%). The primary reasons for not performing the revascularization procedures were the presence of advanced atherosclerotic disease and severe local tissue damage in the lower extremity. More importantly, nearly 50% of all amputations were performed above the knee, the most common level of amputation and a proportion that corresponds with a similar high percentage of Fontaine stage IV ischemia. Hospital stay was on average 7.9 ± 10.2 days, while the longest hospital stay was noted in patients who underwent hip disarticulation, postoperative infections, and reamputation (16, 18.2, and 21 days, respectively).

The overall mortality rate approached almost 7% and was just over 11% in patients with major amputations, and approximately 3% in patients with minor amputations. Most important, mortality predictors were identified as age over 65 years, chronic kidney disease, ischemic heart disease, previous myocardial revascularization, emergency admission, not using aspirin, using previous anticoagulation therapy, and postoperative complications.

The second study included 1681 patients with PAD who were admitted to different hospitals across Serbia from January 2020 to December 2023. The analysis focused on addressing sex-related differences, comorbidities, types of revascularization, procedural characteristics, and associated morbidity and mortality outcomes. Consistent with the findings of the first study, a predominance of male patients was observed (69.5%) with no significant difference in mean age (66.8 years). DM was present in 40.2% of patients, of whom 16.1% were receiving insulin therapy. Approximately 62% of patients were either current or former smokers, while 8% were classified as obese (body mass index $> 30 \text{ kg/m}^2$). The majority of patients underwent elective procedures (83.7%).

Approximately one-quarter of the patients had undergone a previous revascularization procedure. Men were more frequently treated with open surgical approaches, whereas women more often underwent endovascular interventions. Notably, endovascular revascularization procedures were performed significantly more often in patients with DM compared to those without (10.5% and 4.9%, respectively).

Most patients were treated for chronic limb-threatening ischemia, with the largest proportion presenting at Rutherford grade IV (26.4%). Overall, 1227 patients (72.9%) underwent surgical intervention, while 454 (27.1%) received endovascular treatment, reflecting a significant increase in endovascular procedures compared to the first study.

Previous amputation was noted in almost 10% of the patients, with minor amputation being more frequent (6.1%).

The postoperative complication rate was approximately 7.5% and the overall mortality rate was 1.6%, with similar predictors as noted in the first paper. An increased incidence of compartment syndrome and unplanned LEA was noted in patients who underwent prior peripheral revascularization (16.7% and 2.4%), with an overall increase in complication rates (11%).

Discussion

Findings from both papers showed that Serbia faces a combination of challenges contributing to high amputation rates: a high percentage of patients with DM, elevated post-LEA mortality, a low number of previous vascular procedures, delayed recognition of patients at risk, and limited use of diagnostic and endovascular procedures.

All the above prompted a search for effective solutions. By clearly identifying the underlying issues, early diagnosis and timely management of PAD were prioritized, with the goal of

increasing the number of appropriate vascular procedures and reducing the incidence of amputations, consequentially aiming for lower associated mortality rates.

In response to these challenges, Serbia launched a pilot project focused on developing electronic consultations (eConsultations). Utilizing Heliant, the medical information system used by most Serbian hospitals, an eConsultations platform specifically for patients with DM and diabetic foot complications was established. This system enables streamlined communication and coordinated care among primary, secondary, and tertiary health care providers. Currently, there are 6 institutions participating in this project: University Clinical Centre of Serbia (tertiary), Clinical Hospital Center Zvezdara, Clinical Hospital Center Zemun (secondary), and 3 primary health care institutions, which are all located in Belgrade.

This system supports 3 levels of communication pathways:

1. Primary-to-secondary communication

A physician in a primary health care center can send a direct message to a vascular surgeon in a secondary health care institution. The specialist can then provide further instructions regarding the patient's management. This scenario is typically used for patients who do not require additional diagnostic procedures or advanced treatment.

2. Secondary-to-tertiary communication

When a secondary health care institution determines that a case requires more advanced expertise, the message is forwarded directly to a tertiary-level specialist.

3. Primary-to-tertiary communication

The most complex or urgent cases allow primary health care practitioners to contact tertiary institutions directly, ensuring rapid assessment and intervention.

During communication, clinicians can input all relevant clinical data, including pulse palpability, presence of neuropathy, ischemic demarcation, and ulcer characteristics, as well as send a photograph of the affected foot.

Upon receiving a message, physicians in secondary or tertiary centers are alerted through a red-light notification on their Heliant dashboard. After reviewing the patient information, the specialist can take 1 of 2 actions: respond with a detailed instruction for further management or forward the case to a higher-level institution when more advanced care is needed.

Conclusions

This streamlined method of communication has already enhanced early diagnosis and improved the timely identification of patients who require PAD interventions. Although not all the mentioned health care providers were involved from the beginning, and the data entry was not implemented simultaneously across institutions, data from the University Clinical Centre of Serbia indicate a 20% reduction in the number of LEA in 2025. Notably, 263 below-the-knee endovascular procedures were performed

in 2025, representing more than a twofold increase compared with 2024, when 121 such procedures were conducted.

Meanwhile, endovascular peripheral interventions in Serbia have been rapidly developing. Recently, numerous advanced techniques have been incorporated into routine clinical practice, including covered endovascular reconstruction of the aortic bifurcation technique, various atherectomy devices, and intravascular lithotripsy, as well as newly developed devices specifically designed for the treatment of below-the-knee arterial disease. These procedures are performed by interventional radiologists, and the field of interventional radiology is gaining interest among medical students and young physicians. In 2025, the Serbian Society of Interventional Radiologists held its first national congress, providing an important opportunity to assess the current states of practice, identify areas for improvement, and outline directions for further development, including advances in the management of PAD. Notably, this progress has been made possible through the continuous support of the Republic of Serbia and Ministry of Health, which has enabled ongoing advancement and development within the field.

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